FEC

2-F-41

INSTRUCTION MANUAL

REGATRON

POWER SUPPLY

MODEL 220AM

SERIAL No. _____

ELECTRONIC
MEASUREMENTS
COMPANY, INCORPORATED
EATONTOWN · NEW JERSEY

TELEPHONE: (201) LIberty 2-0300 TWX: (201) 542-2273 CABLE: ELMEASCO

Warranty

Electronic Measurements instruments are guaranteed to be free from defects in material and workmanship for one year from the date of purchase (except for tubes, fuses and batteries). Our liability under this warranty is limited to repairs and adjustments or replacements of defective parts or instruments when the fault is a direct result of defective materials or workmanship in the manufacture of the apparatus. This warranty covers service for the first year, except for transportation to and from the factory. If any fault develops in the equipment, the following steps should be taken:

1. Notify ELECTRONIC MEASUREMENTS CO., INC. Give full particulars of the difficulty and include the serial number of the instrument in question. On receipt of this information, we will give you service information or shipping instructions.

2. On receipt of shipping instructions, forward the appartus to us, prepaid, and we will make repairs and adjustments immediately at the factory.

3. If the fault has been caused by misuse, or abnormal conditions of operation, as disclosed by our examination, repairs will be billed at cost. In this case, an estimate of the cost will be submitted before work is started.

ELECTRICAL STANDARDS

All company primary standards are either certified directly or are traceable to certification by the National Bureau of Standards.

CLAIM FOR DAMAGE IN SHIPMENT

This instrument received comprehensive visual and electrical inspections before shipment. Immediately upon receipt from the carrier, and before operation, this instrument should be inspected visually for damage caused in shipment. If such inspection reveals internal or external damage in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. When referring to this instrument, always include the model and serial numbers.

REGATRON

PROGRAMMABLE

POWER SUPPLY

MODEL 220Am

SERIAL No. _____

ELECTRONIC
MEASUREMENTS
COMPANY, INCORPORATED
EATONTOWN · NEW JERSEY

TWX: EAT 984 4-60 TELEPHONE: LIBERTY 2-0300

Warranty

Regatron instruments are guaranteed to be free from defects in material and workmanship for one year from the date of purchase (except for tubes, fuses and batteries). Our liability under this warranty is limited to repairs and adjustments or replacements of defective parts or instruments when the fault is a direct result of defective materials or workmanship in the manufacture of the apparatus. This warranty covers service for the first year, except for transportation to and from the factory.

If, during subsequent service, any fault develops in the equipment, the following steps should be taken:

1. Notify *Electronic Measurements Co. Inc.*, giving full particulars of the difficulty and include the serial number of the instrument in question. On receipt of this information, we will give you service information or shipping instructions.
2. On receipt of shipping instructions, forward the apparatus to us, prepaid, and we will make repairs and adjustments immediately at the factory.
3. If the fault has been caused by misuse, or abnormal conditions of operation, as disclosed by our examination, repairs will be billed at cost. In this case, an estimate of the cost will be submitted before work is started.

CLAIM FOR DAMAGE IN SHIPMENT

This instrument received comprehensive visual and electrical inspections before shipment. Immediately upon receipt from the carrier, and before operation, this instrument should be inspected visually for damage caused in shipment. If such inspection reveals internal or external damage in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. When referring to this instrument, always include the model and serial numbers.

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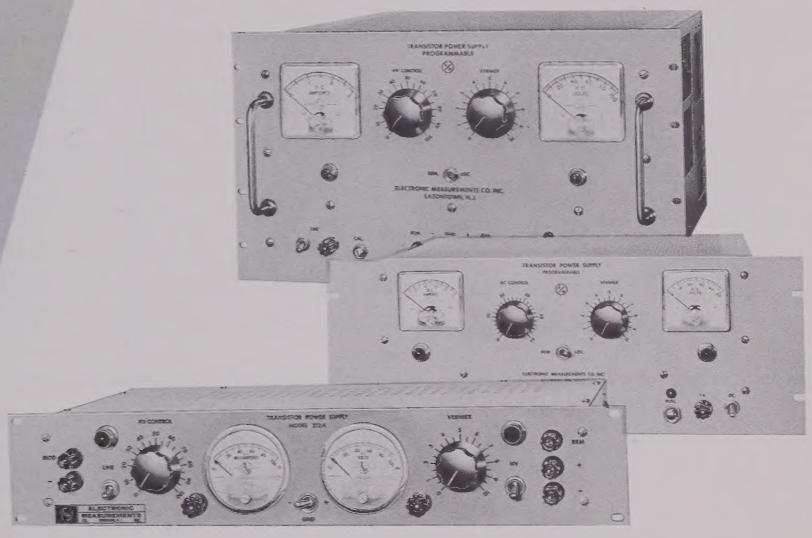
Electronic Measurements Company Inc.
Eatontown, New Jersey

ELECTRONIC
MEASUREMENTS
COMPANY, INCORPORATED
EATONTOWN · NEW JERSEY

SPECIFICATION SHEET
3010B
FEBRUARY 1960



MODEL 218AM
MODEL 213AM
MODEL 212AM

*Regatron Programmable Power Supplies . . . for transistor work

These Programmable Regatrons are especially well suited for the requirements of transistor work. Their versatility and superior characteristics also recommend them for laboratory, production test, and original-equipment applications, wherever highly regulated, wide-range dc power is specified.

- Remote programming with low-power control resistors lends itself to instrumentation for automatic delivery of continuously variable or sequenced voltages.
- Voltages far exceeding specification limits are obtainable at derated currents.
- Super-regulation, negligible ripple, and vernier controls permit useful outputs at a fraction of a volt . . . with rated current available over entire range . . . and remote sensing for full regulation at the load.
- Chopper stabilization, available optionally, permits at least 10X higher order of regulation and stability at low voltage.
- Conversion to constant-current output is made externally.

REGATRON PROGRAMMABLE POWER SUPPLIES

Registered U.S. Patent Office. Patents issued and pending.

Regatron
Programmable Power Supplies

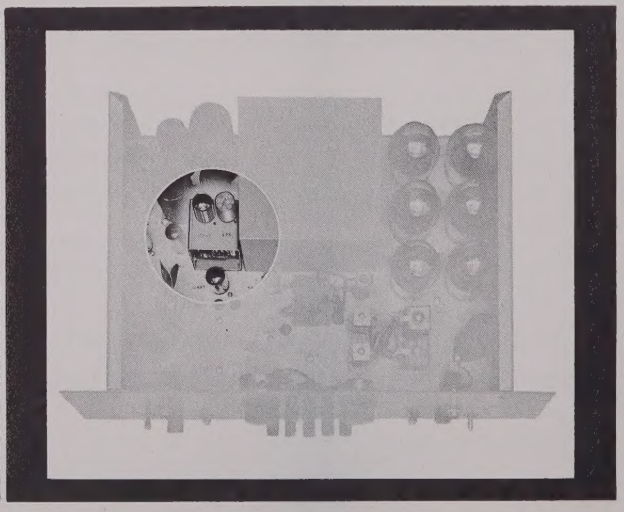
MODEL	DC OUTPUTS Volts	MA	*REGULATION Line 105-125V AC 50-60CPS %	V	No Load To Full Load %	V	MAX. RIPPLE MV. RMS (See Note 6)	INPUT POWER REQUIRED AT FULL LOAD 60CPS, 125V AC Watts	VA
212A[1,2,4]	0-100	0-100	0.15	0.05	0.1	0.05	½	97	106
2-212A[1,4,5]	Equivalent to two Model 212A's. Outputs may be used in parallel, series, or independently.							194	216
213A[1,2]	0-50	0-1,000	0-1	0.05	0.1	0.05	1	324	365
214A[1,2]	0-100	0-1,000	0-1	0.05	0.1	0.05	1	377	427
215A[1,3]	0-50	0-3,000	0-1	0.05	0.1	0.05	1	992	1117
218A[1,3]	0-100	0-3,000	0-1	0.05	0.1	0.05	1	1155	1325
220A[1,2]	0-50	0-500	0-1	0.05	0.1	0.05	1	205	245
221A[1,2]	0-100	0-500	0-1	0.05	0.1	0.05	1	234	282
224A[1,2,4]	0-100	0-200	0.15	0.05	0.1	0.05	1	132	191

Notes

1. For panel meters add the letter M to model number (example 212AM). Panel meters cover exactly the same ranges as the specified voltage and current outputs of the unit. Meter accuracy ±2% full scale.
2. Add $20 for panel meters.
3. Add $25 for panel meters.
4. MOD input terminals to permit modulation of output for measurement of transistor parameters, etc.
5. Model 2-212A is described in detail on Data Sheet 3070. With chopper stabilization, depth of Model 2-212A is 14½ inches. Add $40 for panel meters.
6. Ripple levels are given with either positive or negative output ground.
7. All front panels 19 inches wide, for rack mounting.

Optional Chopper Stabilization for . . .

Chopper Stabilizer 336B34



Chopper Stabilizer Installed

REGULATION
0.01% or 0.003 volts line or load

STABILITY
0.05% + 2 millivolts for 8-hours after 30 minutes warmup

Regatron Programmable Power Supplies are now available with chopper stabilization as an optional feature. Regatrons now in use can also be equipped with chopper stabilization by means of a conversion kit. Price, factory installed or converted, is $75. See Bulletin 375.

■ 0-50, 0-100 Volts

DIMENSIONS IN INCHES (See Note 7) H	D	WEIGHT IN Pounds Approx.	PRICE
3½	9½	14	$129
5¼	9½	21	$258
7	11½	35	$345
7	11½	35	$379
10½	16	75	$670
10½	16	75	$720
5¼	12½	30	$299
5¼	12½	30	$329
3½	9½	16	$189

Further Data on all Models

*REGATRON VOLTAGE REGULATION — Regatron Programmable Power Supplies employ a voltage regulation circuit which renders performance surpassing that of the typical battery. Corrective feedback signals originate at a balanced zero-potential comparator. Together with a high gain amplifier, the comparator provides increasing gain with decreasing output voltage, with full loop gain available at zero voltage. Useful outputs are available even to a fraction of a volt.

† **REGATRON PROGRAMMING**—The term Programming describes the remote control of voltage possible with Regatron Power Supplies. The regulation circuit mentioned above affords a programming feature of great simplicity. Output of a Regatron can be controlled from a remote location with a low power resistor connected to the unit by two wires. Output voltage then varies directly with resistance, or $E_o = KR$ where $K = .001$, that is, 1 volt of output per 1,000 ohms of controlling resistance. (Some Regatron models utilize a 500 ohm constant.) This relationship is linear over the entire output range. The control element may be a fixed resistor. However, if a variable resistor or switch-selected fixed resistors are employed, the Regatron can then be remotely controlled to deliver a programmed, or prearranged supply of continuously variable or discrete voltages in timed sequence. The simplicity of this method lends itself readily to automatic programming, using stepping switches, rotary switches, or driven potentiometers.

As an example, Regatrons deliver automatically sequenced voltages for rapid production test of transistor parameters. Automatic programming of Regatrons for continuously variable voltage has found widespread application in the field of chemical and process control.

STABILITY — Within 0.1% or 50 millivolts, whichever is greater, in 8-hours after 30-minutes warmup, under fixed line, load, and temperature conditions, with precision high-stability external control resistor. With chopper stabilization: 0.05% + 2 millivolts, same conditions.

INTERNAL IMPEDANCE — Less than .01 ohm at low audio frequencies; 0.1 ohm to 10 KC; 1 ohm to 40 KC.

TRANSIENT RESPONSE — For step change from no load to full, or full to no load, output recovers to within dc reg. limits of initial value within 1 millisecond.

AMBIENT TEMPERATURE RANGE — —20° C to +45° C.

OVERVOLTAGE CAPABILITY — See page 4.

† **REMOTE PROGRAMMING RESISTANCE** — 1,000 ohms per volt of output.

CONTROLS — Main control and 10-volt vernier are of wirewound type. Panel calibration is approximate.

CIRCUIT PROTECTION — Input ac line fused. Dc outputs fused.

EXTERNAL REFERENCE — All units except Models 212A, 2-212A, and 224A have rear mounted terminals for conection of an external voltage reference. Models 212A, 2-212A, and 224A are available with such terminals on special order.

OUTPUT POLARITY — Swinging link permits positive or negative ground, or floating output. Model 212A has a panel switch for this purpose.

TERMINATIONS — Front — 5-way insulated binding posts; Rear — barrier-type terminal strips. Line cord is 3-conductor type.

MOUNTING — Units fit 19" standard racks and are equipped with rubber feet for table mounting. Top and bottom are protected by perforated metal covers.

FINISH — Smooth gray semi-gloss enamel Class 2 per MIL-E-15090.

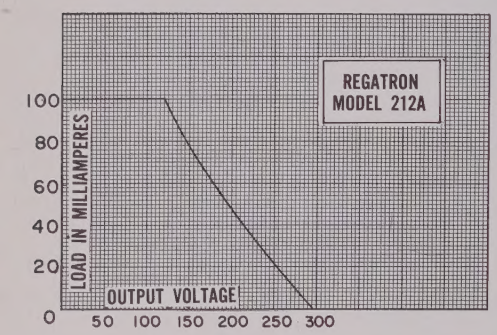
OPTIONS — (a) With meters — add letter M to model number.
(b) With chopper stabilization—add letter K to model number.
(c) With front-only or rear-only terminations. (Front-only normally supplied.) Front-and-rear terminations at extra charge.
(d) Without controls (same price).

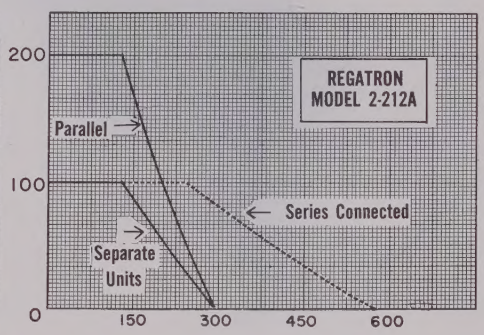
SPECIAL VERSIONS — In addition to the standard options listed above, specially modified versions of standard Regatrons are available on order. Where a Regatron is to be incorporated as original equipment, for example, a typical list of changes often includes blank panels, relays for remote switching, special connectors, and special finishes.

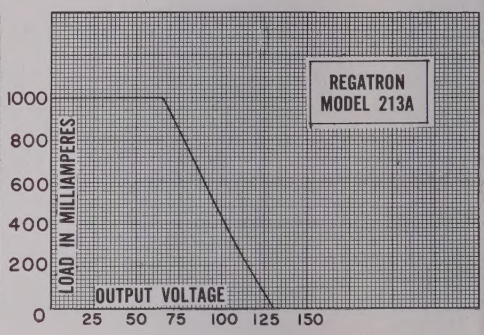
Orders for special versions should state desired modifications clearly in order to save time and guarantee satisfaction. A list of special requirements, as well as knowledge of the intended application, will greatly assist the regional Electronic Measurements sales engineer and the engineers at our factory in tailoring a Regatron to meet your needs optimally.

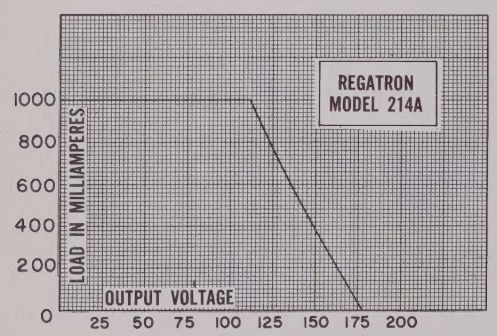
*Current Deratings for Overvoltage Operation

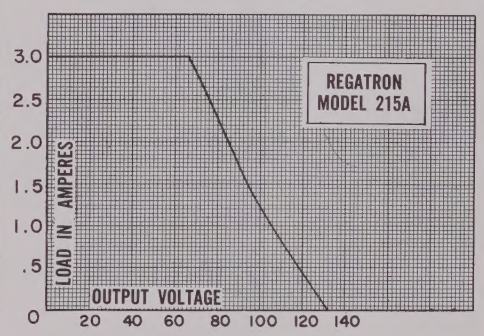
Programmable Regatrons are capable of voltage outputs far exceeding their specification limits, at reduced current levels. For overvoltage, an external programming resistor substitutes for or adds to the resistance of the internal controls, extending the control resistance range, and therefore the output range, in a simple, linear relationship. These graphs show the current deratings of Regatrons in overvoltage operation. For example, at 250 volts, Model 212A delivers up to 20 milliamperes. This output would be obtained by setting controls to zero and shunting a 250,000 ohm resistor across the REM and + terminals. Alternatively, controls could be set for 100 volts, with an external 150,000 ohm resistor across the programming terminals.

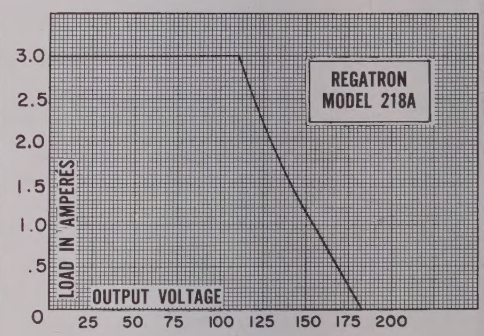


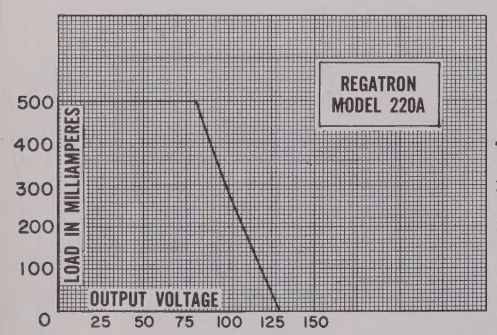


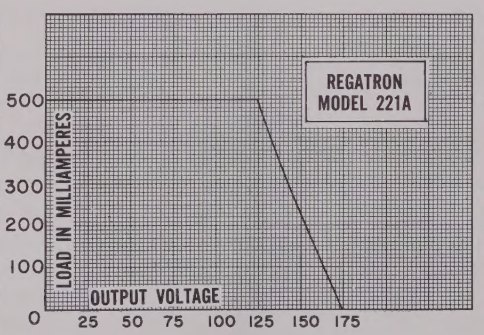


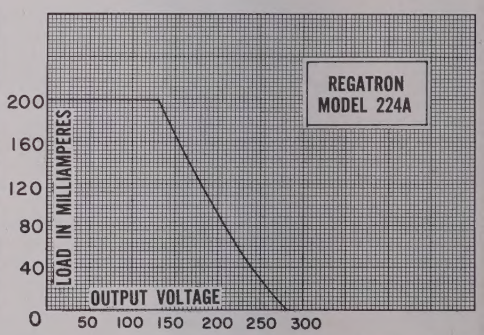












*All derating curves taken at 105 volts ac line input.

ELECTRONIC MEASUREMENTS COMPANY INC., EATONTOWN, NEW JERSEY TELEPHONE: LIberty 2-0300 TWX: EAT 984

ELECTRONIC MEASUREMENTS COMPANY, INCORPORATED
EATONTOWN • NEW JERSEY

I. GENERAL

1. DESCRIPTION:

This Power Pack is a compact source of D.C. power especially designed to provide steady low voltages such as are required in transistor work. The use of a 10 volt electrical vernier makes practical the resolution of small voltages to a fraction of a volt. Extremely low ripple and good regulation provide performance superior to that of the average battery. For this reason, coupled with its very light weight, this unit finds ready application as a general purpose battery for the laboratory or shop, comprising such uses as bridge power, test voltage, strain gauge excitation, etc. In addition, this unit is programmable, that is, it may be controlled or programmed from a central point. The design makes this possible by very simple means so that the proper control or programming function can be readily incorporated in automatic switching devices.

2. INSPECTION:

After unpackaging the unit, inspect the tubes to see that they are securely in their sockets. Enclosed units may be inspected internally by removing the cover screws and sliding the cover backwards.

II. INSPECTION

1. POWER:

This unit requires a source of 105 to 125 volts A.C. at 50 to 60 cycles.

2. PLACEMENT:

Cabinet units may be placed on a flat surface on the rubber feet provided. Rack units may be located in the same fashion or attached to a rack panel having standard rack drilling. When placing the unit in position, ventilation openings should be left clear. If mounted in a rack, this consideration should be kept in mind.

III. OPERATION

1. PRELIMINARY:

General Purpose Use: This unit may be used as a general purpose power supply. To so employ it proceed as follows:

a. Place the switches and controls in the following positions:
   (1) Line and high voltage switches - off (down).
   (2) H.V. control and vernier - Minimum (counter clockwise).
   (3) Local remote switch - Local.

b. Make load connections to the binding posts at the front of the unit.

NOTE

The regulation of this unit is measured at the binding posts; in use, the load leads should be made heavy enough to reduce the drop to acceptable limits.

c. Plug the line cord into an appropriate outlet. Operate the line switch to the on position (green indicator will glow).
d. After about a minute apply voltage to the load by operating the high voltage switch to the on position (up, red indicator will glow).

WARNING

When first turning on this unit, the D.C. switch should always be in the off position. It is arranged to throw a short across the output binding posts, thus effectively preventing the application of any excess voltages to the load during warm-up. Subsequently, the D.C. switch may be operated on or off with no danger of exceeding the set voltage.

3. ADJUSTMENT OF VOLTAGES:

3.1 High Voltage Control:
This control covers the complete range. Set the control to the desired voltage employing the panel calibration or the meter, where supplied.

3.2 Vernier:
This control covers 0 to 10 volts. When set to any value this reading should be added to that of the HV control reading to obtain the total output voltage. When using voltages of 10 volts or less it is advisable to set the high voltage control to zero and use only the vernier to realize its greater steadiness.

4. REVERSAL OF POLARITY:

This power unit has been designed so that either side of the high voltage may be grounded to the case as desired. The unit is normally supplied with the negative side grounded. To reverse polarity. loosen the three (3) high voltage binding posts, swing the link to the other post and retighten the two (2) posts on the link. The load connection for the ground side may be inserted either under the ground post or the grounded terminal.

5. REMOTE CONTROL USE:

NOTE

Production units are normally calibrated to make panel calibrations approximately correct. Thus, depending on the tolerance of the internal potentiometer, the calibration may be somewhat more or less than 1,000 ohms per volt.

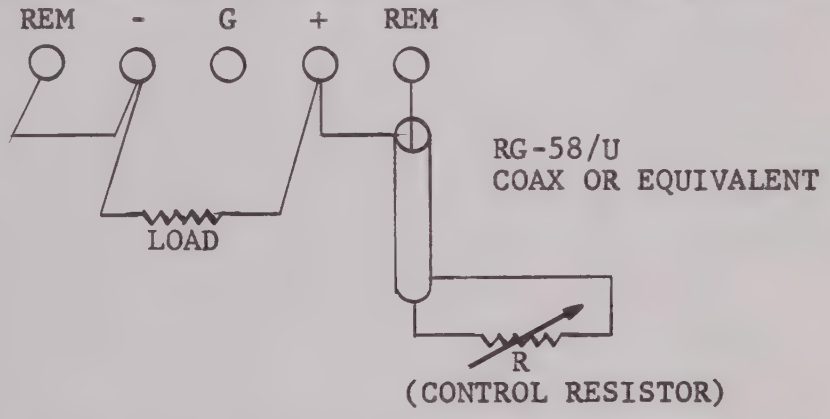
Accordingly, if precisely 1,000-ohms-per-volt is desired for remote use, one of the following will be necessary;
(a) Call for 1,000-ohm-per-volt calibration when ordering.
(b) Recalibrate in the field (see below).

Two modes of operation are possible in operating this unit by remote control. They will be described in order of the most probable useage below.

MODE 1:

This method provides remote control without load sensing; therefore, the length of leads between the terminal posts and the load will influence the amount of voltage drop.

a. Throw the local remote switch to REM and make connections as indicated below. Make certain that the outer sheath of the coax line is connected to the plus output post.

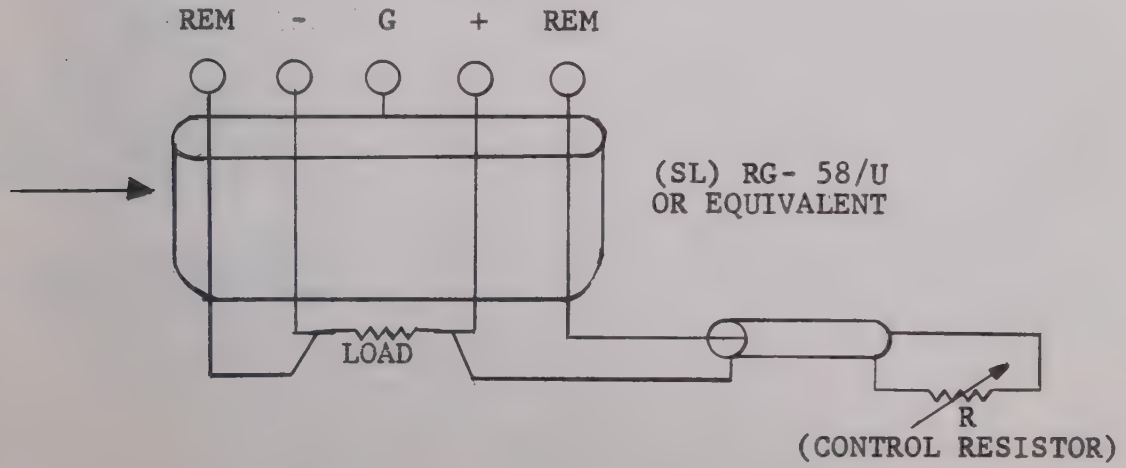


b. Set the high voltage and vernier controls to zero.
c. For each 1,000 ohms inserted at the end of the coax line, 1 volt will be developed by the power supply.

MODE 2:

This method of operation provides sensing at the load and eliminates the effect of lead drop.

a. Make connections as shown below:



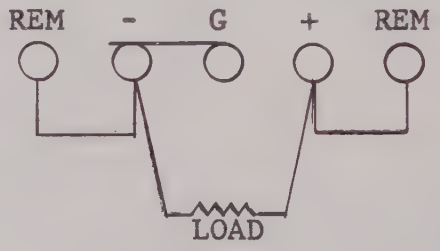
b. Set the high voltage and vernier controls to zero.
c. As above, one volt will be developed for each 1,000 ohms inserted across the control lines.

The control resistance R can be employed close to the load, in which case no shielded line will be required. It may also be located remotely from load and power supply, in which case a shielded line (SL) will be required connected as shown in the diagram.

5. REAR TERMINATIONS:

These units may be supplied with rear terminations in place of the front terminations and, in some instances, with both front and rear terminations. When rear terminations alone are supplied these may be treated in the same manner described above for front terminations.

Where both are supplied some difference in operation is involved for local use, if the rear terminations are employed. Under these conditions proceed as follows:
a. Throw the local remote switch to Remote:
b. Place two jumpers on the rear terminals as indicated in the diagram below.



For remote use either set of terminals may be employed in the normal manner. Control will then be derived from the particular set of terminals in use.

6. EXTERNAL REFERENCE:

Reference glow tubes experience a progressive change of voltage with time. For example, a typical change is 1/2% for 1,000 hours of use. Where a highly precise reference voltage is available (negative with respect to the negative bus of the power supply) it may be employed in place of the internal reference by connecting to the terminals provided at the rear for this purpose. To do this proceed as follows:
a. Remove the connections across Terminals 1 and 2.
b. Connect the external reference voltage to Terminals 2 and 3 with the positive side of the external reference connected to Terminal 3.

Any reference voltage of 85 volts or more may be used; however, for each volt over 87 volts, provided by the external reference 1,000 ohms of resistance should be inserted in the line between the reference potential and the external reference terminal on the unit. For example, if a reference of -150 volts is available, a resistor of 63,000 ohms, ±1% should be provided. This resistor should be of a wire-wound type with high stability alloy, since it will directly influence the stability of the output voltage.

IV. MAINTENANCE

1. REPLACEMENTS:

When replacements are required any part may be used of the values and tolerances indicated on the circuit diagram. However, replacement of some parts may require recalibration and/or resetting of the null adjustment.

2. SERIES TUBES:

The following instructions apply for units having one or more series tubes. If, at any time, it is believed that one or more series tubes and associated circuits are faulty, this may be checked as follows:

a. Remove all series tubes but one.
b. Turn on the equipment and apply 1/N of full load current at some low voltage (N- number is series tubes).
c. Remove this series tube and place another series tube in another socket and repeat b.
d. Repeat b for every other socket and tube, taking one at a time.
e. If one or more of the circuits shows faulty, repeat the test in each case using a tube known to be good.
f. If a favorable result is obtained, it may be taken that the previous tube is faulty. If not, the associated circuits should be checked for faults.

2.1 Miniature Tubes and Regulators:
Changing some of these tubes may affect the zero balance so it should be checked in accordance with the instructions below.

2.2 85A2 Reference Tube:
Changing this tube affects the reference voltage; therefore, it will be necessary to perform the calibration adjustment in accordance with instructions below.

2.3 High Voltage and Vernier Controls:
If either of these potentiometers becomes faulty, a replacement should be obtained providing the proper effective arc to fit the panel calibration. The calibration arc is 280°. If desired, replacements may be obtained from the factory.

3. ZERO ADJUSTMENT:

The zero adjustment is used to set the input comparator system to a zero level, which then holds over the entire operating range. This control may be found on the chassis. To set this adjustment, proceed as follows:

a. Turn the unit on and rotate the high voltage and vernier controls to zero.
b. Connect a voltmeter to the high voltage output terminals (full scale sensitivity 3 volts D.C. or less).
c. Set this control to obtain a reading of zero. A very sensitive indication may be obtained by alternately connecting and disconnecting the voltmeter lead.

4. CALIBRATION ADJUSTMENT:

Calibration may be performed in one of two ways;
a. To make the panel calibrations read correctly.
b. To provide remote control calibration of 1,000 ohms-per-volt.
To perform the calibration adjustment a reasonable precise meter or source of voltage must be available. The preferred calibrating voltage is 100 volts (or 50, if this is maximum output voltage) if available.

a. Connect the power unit to the measuring device.
b. Set the vernier control to zero and the high voltage control, to read 100 volts. For external resistance control, set both controls to zero and the external resistance to precisely 100,000 ohms.
c. Set the calibrating control to read 100 volts.

V. APPLICATION NOTES

1. RESOLUTION:

Because only 100 volts is covered in the rotation of the high voltage control good resolution is realized. However, where high resolution is desired, the high voltage control may be used for a coarse setting and the vernier for fine setting. For voltages of 10 volts or less the vernier alone may be used (with HV control at zero) to realize improved stability.

2. USE AS A VOLTAGE STANDARD.

If a precision decade box is available, this unit may readily be used as a shop voltage standard. After calibrating the unit in accordance with the instructions given above, the output voltages may be read directly from the decade dials. Thus the thousand-per-step-dial may be used for volts, the ten-thousand-per-step-dial for tens of volts and the hundred-thousand-per-step-dial for hundreds of volts. If we neglect the aging of the internal reference, the accuracy of the voltage under these conditions will be slightly

poorer than the decade box, even for a decade accuracy as good as 0.1%. The aging of the internal reference may be nullified by recalibration after every thousand hours or so of use.

3. PROGRAMMING SUGGESTIONS:

If the method of programming is like that described for MODE 1 above, only two connections are required to control this power supply. Most automatic systems have switch connections available for auxiliary devices. However, where this in not the case, a rotary stepper switch may be employed, each level of which can be used to control a power supply of this type. Thus, if a number are used in a program, say ten, one stepper can be used to set the entire battery to a number of different settings upon command from a central system. An illustrative sketch is given on the next page. A large number of possibilities will generally suggest themselves to the user.

ELECTRONIC MEASUREMENTS COMPANY, INCORPORATED
EATONTOWN · NEW JERSEY

TECHNICAL NOTE 21B
OCTOBER 1959

Regatron Programmable Power Supplies:

The Programming Concept

The Programmable *REGATRON is a new type of power supply designed to meet the need for remote control arising out of the increasing tendency towards automation, centralized control, etc. The word "programmable" has been coined to describe the ability of the unit to be controlled, or programmed from a remote or central point.

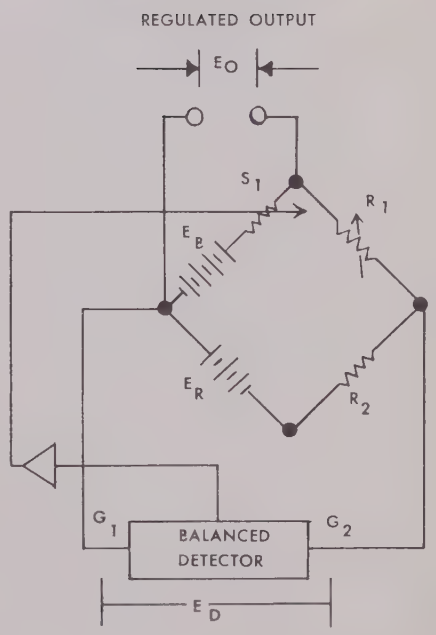
CONTROL METHOD

In the REGATRON control system, programmability is provided by a very simple means.

In Figure 1. E_B is a supply of unregulated voltage, E_0 is the regulated output potential controlled by some sort of series element, S_1; E_R is a reference potential; R_1 is a control resistor; and R_2 is a standard resistor. G_1 and G_2 are the grids of a balanced detector. If matters are so arranged that the voltage E_D at the detector grids is zero, then it must be true that

$$\frac{E_0}{E_R} = \frac{R_1}{R_2} \quad \text{and obviously} \quad E_0 = E_R \times \frac{R_1}{R_2}$$

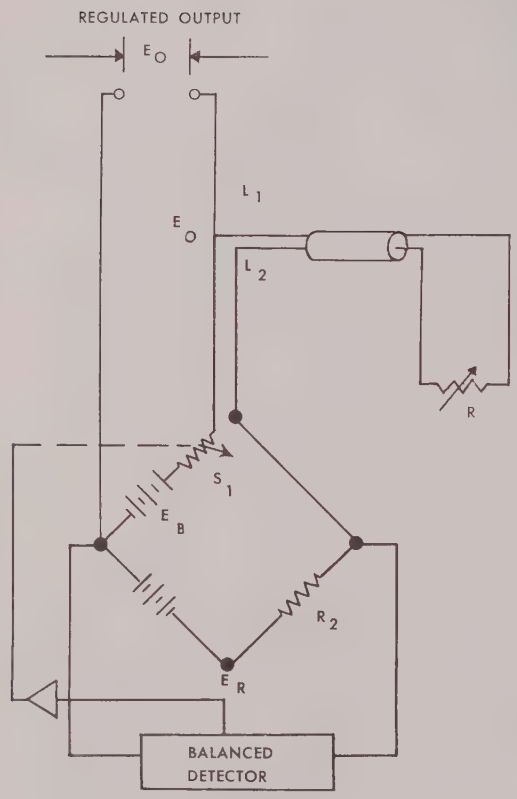
FIGURE 1
CONTROL SYSTEM



*Reg. U. S. Pat. Off.
Patents Pending

FIGURE 2

THE PROGRAMMING FACILITY



However, since E_R and R_2 are constant, then we may say that $E_0 = KR_1$. Under these conditions, therefore, the output voltage is only dependent upon the magnitude of R_1.

With the passage of time, the detector system, even though carefully designed may depart from zero thereby disturbing the above relationship. Accordingly, if means are provided to apply an external detector (such as a meter) to points G_1 G_2, it is only necessary to adjust the balanced detector for zero difference to eliminate control system error. Assuming suitable resistors are employed, the error will then depend entirely on the reference voltage E_R.

REMOTE CONTROL

Figure 2 makes clear the manner in which this system permits simple remote control. Lines L_1 and L_2 may be extended any reasonable distance via coaxial line. Subsequently the system will develop the voltage called for by the resistor R according to the simple law above. By a simple extension of this thinking, connections may be arranged to permit sensing of both load terminals to eliminate the effects of lead drop.

(The above does not, of course, discuss any of the circuit devices employed to produce the requisite gain, operating potentials, etc.)

CENTRAL CONTROL

It is evident from the above, that the voltage controls for all of the power supplies in a test console can be brought to a central operating point, thus facilitating manipulation by the operator. (Figure 3)

The controls at the operator's position can consist of calibrated rheostats, switches and resistors, etc., to provide any degree of control and/or calibration desired.

PROGRAMMING SUGGESTIONS

Most automatic systems have switch connections available for auxiliary devices. Thus, if the two wire programming method is employed, it is only necessary to have sufficient contacts to switch in a new resistor for each potential desired. In fact, one side can be made common thus requiring only one tap.

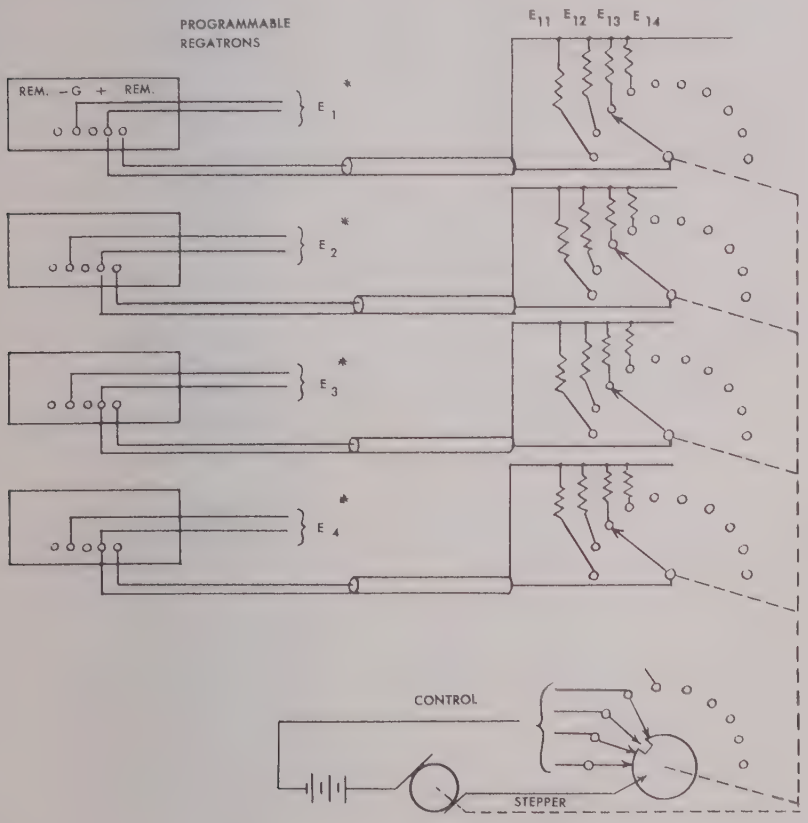


FIGURE 3

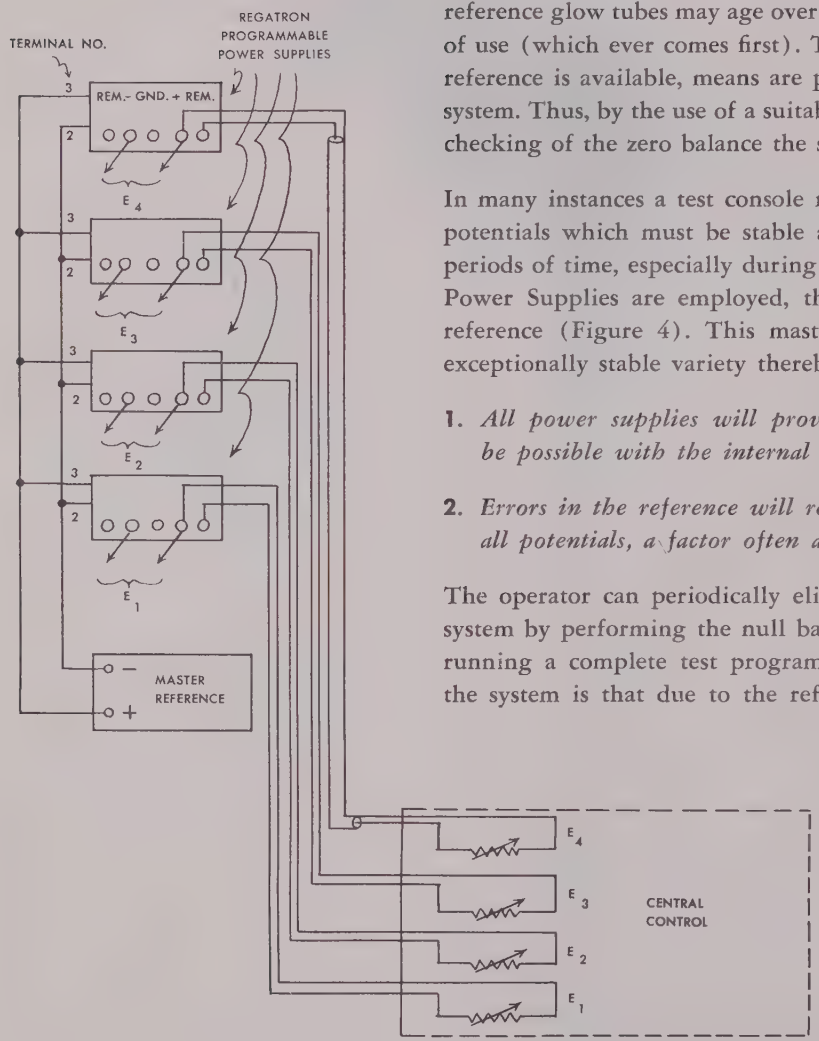
VOLTAGE PROGRAMMING WITH AUTOMATIC STEPPER SWITCH

*E_1-E_2-E_3-E_4 are the useful output voltages to be applied to the points requiring programming. Alternatively, they may be routed through additional automatic switches if redistribution of potentials is required during the program.

However, where suitable contacts are not available, a rotary stepper switch may be employed, each level of which can be used to control a power supply of this type. Thus, if a number are used in a program, say ten, one stepper can be used to set the entire battery to a number of different settings upon command from a central system. An illustrative sketch is given in Figure 3. A large number of possibilities will generally suggest themselves to the user.

FIGURE 4

MASTER REFERENCE SYSTEM



SYSTEM POWER

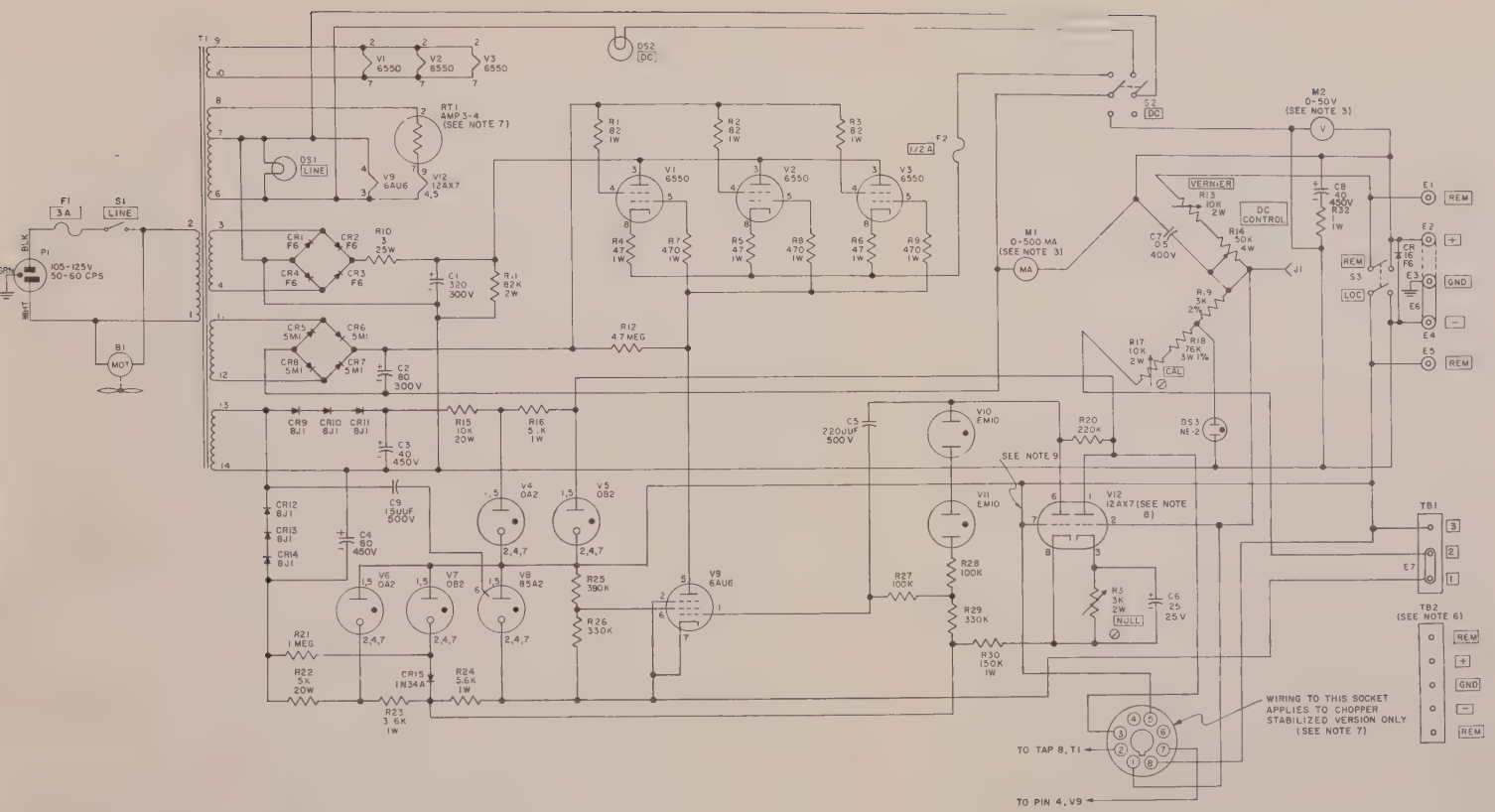
All units are provided with a suitable internal reference; however, reference glow tubes may age over 1/2% within 1 year or 1,000 hours of use (which ever comes first). Therefore, where a better external reference is available, means are provided for its connection to the system. Thus, by the use of a suitable external reference and periodic checking of the zero balance the system may be as good as desired.

In many instances a test console requires a number of controllable potentials which must be stable and reproducible over substantial periods of time, especially during a test program. If Programmable Power Supplies are employed, they can be slaved to one master reference (Figure 4). This master reference can be made of an exceptionally stable variety thereby giving rise to two advantages:

1. *All power supplies will provide greater stability than would be possible with the internal gas tube reference.*

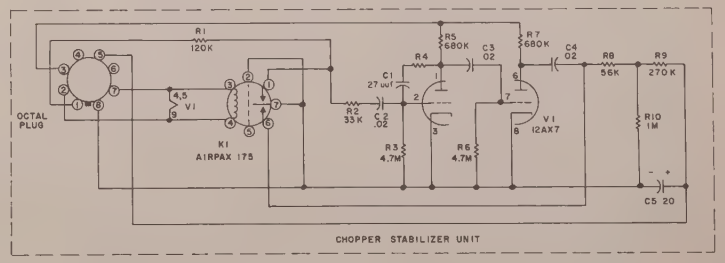
2. *Errors in the reference will result in the same contribution to all potentials, a factor often as important as absolute stability.*

The operator can periodically eliminate the error of each control system by performing the null balance check (for example, before running a complete test program). The error then remaining in the system is that due to the reference potential.



NOTES:

1. Unless otherwise specified, all capacitance values are in UF, all resistance values are in ohms.
2. Unless otherwise specified, all resistors are ½ watt.
3. Meters supplied with models 220AM, AMK only.
4. ⊘ Denotes screwdriver adjustment on panel.
5. ▭ Denotes equipment marking.
6. TB2 is supplied only on units with rear terminations.
7. RT1 is removed on chopper-stabilized version. Octal socket is then wired as shown, and chopper-stabilizer unit plugged in.
8. Chopper-stabilized version employs a 12AY7 tube for V12 instead of a 12AX7.
9. This connection removed for chopper-stabilized version.
10. On units without controls, VERNIER R13 and DC CONTROL R14 are removed and connection is made directly from pin 2 of V12 to the REM terminal E1.



Schematic Diagram, Regatron Model 220A, AM, AK, AMK Programmable Power Supply

ELECTRICAL PARTS LIST

CHOPPER STABILIZER UNIT 336B34

REF SYMBOL	DESCRIPTION	PART OR TYPE NO.	MFR. SYMBOL
C1	Capacitor, mica, 27 UUF, 500VDC	CM19B270-J	MICAMOLD
C2	Capacitor, paper, .02 UF, 400VDC	354A-168	MICAMOLD
C3	Capacitor, paper, .02 UF, 400VDC	354A-168	MICAMOLD
C4	Capacitor, paper, .02 UF, 400VDC	354A-168	MICAMOLD
C5	Capacitor, electrolytic, non-polarized, tantalum 20 UF, 150VDC	TAE20-25SDLK-NP	*I.E.I.
K1	Chopper, SPDT	175	AIRPAX
R1	Resistor, fixed, comp., 120K ±10%, ½W	EB	AB
R2	Resistor, fixed, comp., 33K ±10%, ½W	EB	AB
R3,R6	Resistor, fixed, comp., 4.7 MEG ±10%, ½W	EB	AB
R4	Resistor, fixed, comp., 100K ±10%, ½W	EB	AB
R5,R7	Resistor, fixed, comp., 680K ±10%, ½W	EB	AB
R8	Resistor, fixed, comp., 56K ±10%, ½W	EB	AB
R9	Resistor, fixed, comp., 270K ±10%, ½W	EB	AB
R10	Resistor, fixed, comp., 1 MEG ±10%, ½W	EB	AB
V1	Tube, 12AX7	12AX7	RCA

* *International Electronic Industries, Inc.*

ELECTRONIC MEASUREMENTS CO., INC. ADDENDUM #2060

PARTS LIST CHANGE

MODELS 220A-AK/221A-AK

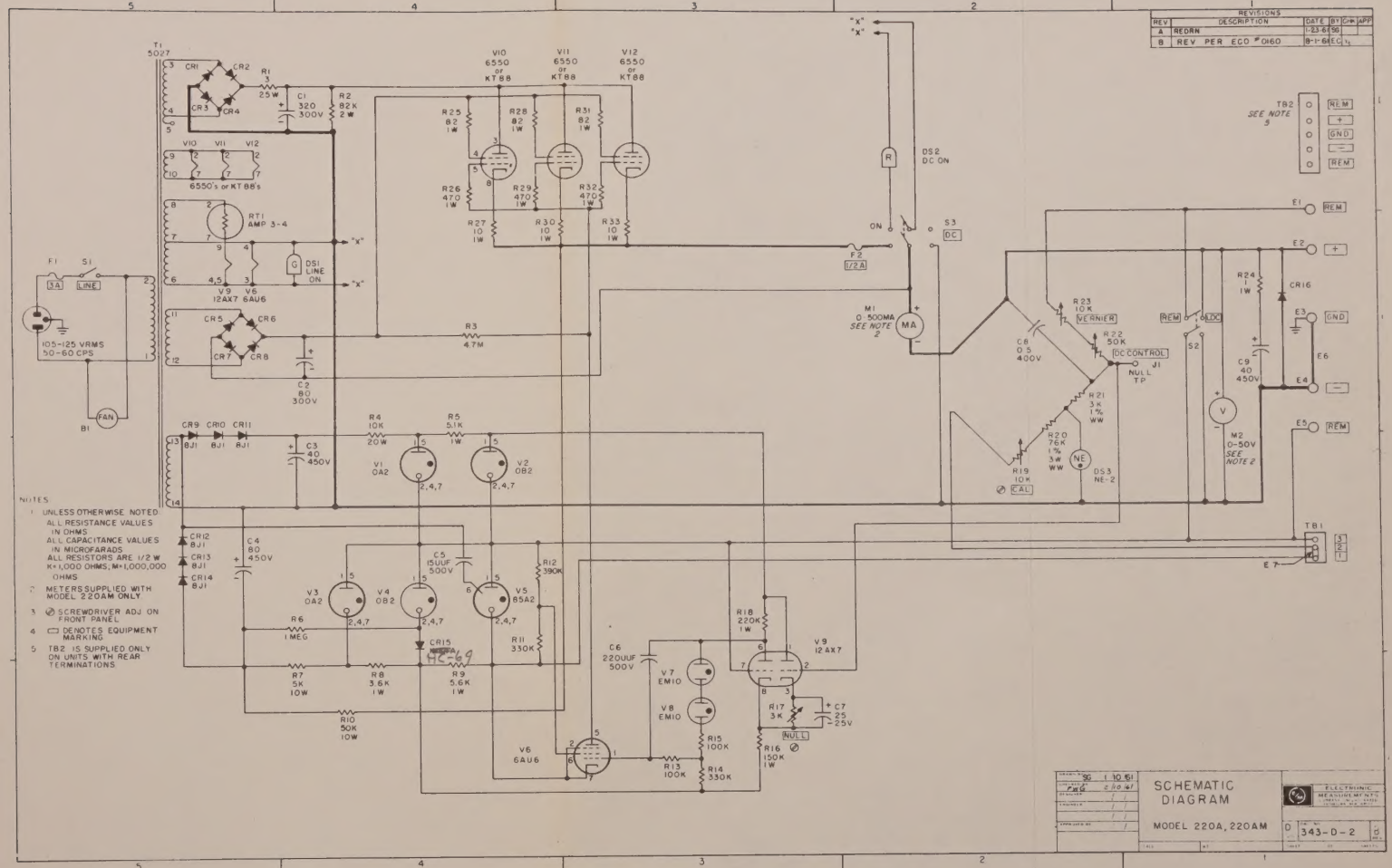
8-21-62	CR15, diode, silicon	HC-69	Solitron

PARTS LIST 7/61

MODELS 220A/AK, 221A/AK

REFERENCE SYMBOL	DESCRIPTION	TYPE OR PART NO.	MANUFACTURER
B1	Motor, shaded pole, 115V, 50-60 CPS, 4 in. fan blade	DYAB-570-3	Barber-Colman
C1	Capacitor, electrolytic, 320 UF, 300 VDC, insl. sleeve	D31962	Sprague
C2	Capacitor, electrolytic, 80 UF, 300 VDC, insl. sleeve	D31964	Sprague
C3,9	Capacitor, electrolytic, 40 UF, 450 VDC, insl. sleeve	D19939	Sprague
C4	Capacitor, electrolytic, 80 UF, 450 VDC, insl. sleeve	D15911	Sprague
C5	Capacitor, mica, 15 UUF ±5%, 500 VDC	CM20B150J	Micamold
C6	Capacitor, mica, 220 UUF ±5%, 500 VDC	CM20B221J	Micamold
C7	Capacitor, electrolytic, 25 UF, 25 VDC, insl sleeve	KE-25/25	Frako
C8	Capacitor, mylar, 0.5 UF +20% -10%, 400 VDC	Type 2110-BM	Chicago Cond.
	Line cord, 7' lg. #18 gauge, 3 cond. 3 prong plug	346-B-52	EMC
CR1-CR8,16	Rectifier, silicon	CER71	Solitron
CR9-CR14	Rectifier, selenium	8J1	Radio Receptor
CR15	Diode, germanium	1N34A	Sylvania
DS1,2	Lamp, 6.3V, 0.25A.	44	G.E.
DS3	Lamp, neon	NE-2	EMC
E1,2	Post, binding, red	29-3R	Grayhill
E3,4,5	Post, binding, black	29-3B	Grayhill
E6	Shorting link	938-L	General Radio
E7	Shorting link	141-J	Cinch-Jones
F1	Fuse, cartridge, 3A.	3AG3	Sightmaster
F2	Fuse, cartridge, ½A.	3AG½	Sightmaster
J1	Tip jack, nylon	105-603	E.F. Johnson
J3	Socket, 8 pin, octal (stabilizer connector or RT-1)	9751-9	Eby
M1	Milliammeter, 0-500 MADC ±2% accuracy full scale (220,221 AM/AMK)	Model 649/MA500	EMC
M2	Voltmeter, 0-50 VDC ±2% accuracy full scale (220AM/AMK)	Model 649/V50	EMC
M2	Voltmeter, 0-100 VDC ±2% accuracy full scale (221AM/AMK)	Model 649/V100	EMC
R1	Resistor, fixed, WW, vitreous enamel, 3 ±5%, 25W	25P3	Ward Leonard
R2	Resistor, fixed, comp, 82K ±10%, 2W	HB-8231	Allen-Bradley
R3	Resistor, fixed, comp, 4.7 megohms ±10%, ½W	EB-4751	Allen-Bradley
R4	Resistor, fixed, WW, vitreous enamel, 10K ±5%, 20W	Type 'Brown Devil'	Ohmite
R5	Resistor, fixed, comp, 5100 ±5%, 1W	GB-5125	Allen-Bradley
R6	Resistor, fixed, comp, 1 megohm ±10%, ½W	EB-1051	Allen-Bradley
R7	Resistor, fixed, WW, vitreous enamel, 5K ±5%, 10W	10X5000	Ward Leonard
R8	Resistor, fixed, comp, 3600 ±5%, 1W	GB-3625	Allen-Bradley
R9	Resistor, fixed, comp, 5600 ±5%, 1W	GB-5625	Allen-Bradley
R10	Resistor, fixed, WW, vitreous enamel, 50K ±5%, 10W	10X50000	Ward Leonard
R11,14	Resistor, fixed, comp, 330K ±10%, ½W	EB-3341	Allen-Bradley
R12	Resistor, fixed, comp, 390K ±10%, ½W	EB-3941	Allen-Bradley
R13,15	Resistor, fixed, comp, 100K ±10%, ½W	EB-1041	Allen-Bradley
R16	Resistor, fixed, comp, 150K ±10%, 1W	GB-1541	Allen-Bradley
R17	Resistor, variable, WW, 3000 ±5%, 2W, linear taper, ¼ in. dia., 1/8 in. lg. slotted shaft, series 43	CM18923	Clarostat
R18	Resistor, fixed, comp, 220K ±10%, 1W	GB-2241	Allen-Bradley
R19	Resistor, varisble, WW, 10K ±5%, 2W, linear taper, ¼ in. dia., 1/8 in. lg. slotted shaft, series 43	CM18924	Clarostat
R20	Resistor, fixed, WW, 76K ±1%, 3W	Type P3-W	Precision Resistor
R21	Resistor, fixed, WW, 3000 ±1%, ½W	Type TX-178	Precision Resistor
R22	Resistor, variable, WW, 50K ±5%, 3W, linear taper, ¼ in. dia., ⅜ in. lg. shaft, series 58 (220A/AK)	CM20403	Clarostat
R22	Resistor, variable, WW, 100K ±5%, 4W, linear taper, ¼ in. dia., ⅜ in. lg. shaft, series 10 (221A/AK)	CM18927	Clarostat
R23	Resistor, variable, WW, 10K ±5%, 2W, linear taper, ¼ in. dia., ⅜ in. lg. shaft, series 43	CM21189	Clarostat
R24	Resistor, fixed, WW, 1 ±5%, 1W	BW1	Int'l Resistance
R25,28,31	Resistor, fixed, comp, 82 ±10%, 1W	GB-8201	Allen-Bradley
R26,29,32	Resistor, fixed, comp, 470 ±10%, 1W	GB-4711	Allen-Bradley
R27,30,33	Resistor, fixed, comp, 10 ±10%, 1W	GB-1001	Allen-Bradley
RT-1	Ballast tube (220,221A/AM)	Amp 3-4	Amperite
S1	Switch, toggle, SPST	160-73	Carling Electric
S2	Switch, toggle, DPST	2BK62-73	Carling Electric
S3	Switch, toggle, DPDT	2GL53-73	Carling Electric
T1	Transformer, filament & power	5027	EMC
TB1	Barrier strip, 3 terminal	3-141-Y	Cinch-Jones
TB2	Barrier strip, 5 terminal (rear termination only)	5-141-Y	Cinch-Jones
V1,3	Electron tube	OA2	RCA
V2,4	Electron tube	OB2	RCA
V5	Electron tube	85A2/OG3	Amperex
V6	Electron tube	6AU6	RCA
V7,8	Electron tube, neon	EM10	EMC
V9	Electron tube, (220,221A/AM)	12AX7	RCA
V9	Electron tube (220,221AK/AMK)	12AY7	G.E.
V10,11,12	Electron tube	6550 or KT-88	Tung-Sol British Ind.
XDS1	Holder assembly, pilot lamp, green faceted lens	100	Drake Mfg.
XDS2	Holder assembly, pilot lamp, red faceted lens	100	Drake Mfg.
XF1,2	Extractor post, fuse, miniature	342003	Littelfuse
XV1-XV6	Socket, 7 pin, miniature	53P24022	Cinch-Jones
XV9	Socket, 9 pin, noval	14502	Cinch-Jones
XV10,11,12	Socket, 8 pin, octal	9751-9	Eby

Manufacturer's part numbers are indicative of stock employed at the time of compilation of this parts list. Unless otherwise noted, and except for Electronic Measurements (EM) part numbers, equivalent parts may be used for replacement.


REVISIONS
REV DESCRIPTION DATE BY CHK APP
A REDRN 1-23-61 SG
B REV PER ECO #0160 8-1-61 EG
T1 5027
CR1 CR2 CR3 CR4
R1 1 2.5W
C1 320 300V
R2 82K 2W
V10 6550 or KT88
V11 6550 or KT88
V12 6550 or KT88
6550's or KT88's
RT1 AMP 3-4
V9 12AX7 6AU6
DS1 LINE ON
F1 3A
S1 LINE
105-125 VRMS 50-60 CPS
B1 FAN
CR5 CR6 CR7 CR8
C2 80 300V
R3 4.7M
CR9 CR10 CR11 8J1
C3 40 450V
R4 10K 20W
R5 5.1K 1W
V1 0A2
V2 0B2
CR12 8J1
CR13 8J1
CR14 8J1
C4 80 450V
C5 150UUF 500V
R12 390K
V3 0A2
V4 0B2
V5 6SA2
R6 1 MEG
R7 5K 10W
R8 3.6K 1W
R9 5.6K 1W
CR15 HC-69
R11 330K
R10 50K 10W
V6 6AU6
C6 220UUF 500V
V7 EM10
V8 EM10
R13 100K
R14 330K
R15 100K
R16 150K 1W
R17 3K
C7 25 25V
R18 220K 1W
V9 12AX7
R25 82 1W
R28 82 1W
R31 82 1W
R26 470 1W
R29 470 1W
R32 470 1W
R27 10 1W
R30 10 1W
R33 10 1W
"X"
"X"
R
DS2 DC ON
ON
S3 DC
F2 1/2A
M1 0-500MA SEE NOTE 2
MA
R23 10K VERNIER
R22 50K DC CONTROL
J1 NULL TP
C8 0.5 400V
R21 3K 1% WW
R20 76K 1% 3W WW
R19 10K CAL
NE 2
DS3 NE-2
V
M2 0-50V SEE NOTE 2
REM
DC
S2
R24 1 1W
CR16
C9 40 450V
TB2 SEE NOTE 3
REM
+
GND
-
REM
E1
E2
E3
E4
E5
E6
E7
TB1
3
2
1
NOTES
1 UNLESS OTHERWISE NOTED ALL RESISTANCE VALUES IN OHMS ALL CAPACITANCE VALUES IN MICROFARADS ALL RESISTORS ARE 1/2 W K=1,000 OHMS, M=1,000,000 OHMS
2 METERS SUPPLIED WITH MODEL 220AM ONLY
3 SCREWDRIVER ADJ ON FRONT PANEL
4 DENOTES EQUIPMENT MARKING
5 TB2 IS SUPPLIED ONLY ON UNITS WITH REAR TERMINATIONS
SCHEMATIC DIAGRAM
MODEL 220A, 220AM
ELECTRONIC MEASUREMENTS
343-D-2

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